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Effect of different rooting media treatments on rooting and growth of stem cuttings in pomegranate (*Punica granatum* L.)

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Abstract
The experiment was laid out using RBD with three rooting media. The stem cuttings when grown in Soil + Sand + Vermi-compost rooting medium had recorded significantly earliest sprouting and highest survival, shoot and root growth of stem cutting. However, among the treatments applied to stem cuttings, poor survival, shoot and root growth of stem cutting were observed with grown in Soil + Sawdust + Vermi-compost. Among the rooting media Soil + Sand + Vermi-compost exhibited profound effects on the performance of stem cutting.

Keywords: Pomegranate, ganesh, hardwood stem cutting and rooting media

Introduction

Pomegranate belongs to the family Punicaceae. The genus 'Punica' has two species viz., *Punica granatum* (cultivated pomegranate) and *Punica protopunica* (wild pomegranate). Pomegranate is basically diploid in nature with 2n=2x=16, 18 chromosomes**.** The number of chromosome in the somatic complements of cvs., Dholka, Ganesh, Kandhari, Muscat White and Patiala were found to be 2n=16, while the cv. Double Flower (ornamental type) had 2n=18**.** The chromosome number in cvs. Vellodu and Kashmiri were found to be 2n=2x=18**.** Botanically the type of pomegranate fruit is berry balausta. The pomegranate (*Punica granatum* L.) is believed to be originated from Iran (Primary centre of Origin). The usage of pomegranate is deeply embedded in human history with references in many ancient cultures about its use in food and medicine (Holland *et al*., 2009) [8]. It is one of the oldest known edible fruits and is associated with ancient civilizations of the Middle East.Quality of planting material is always prime need to the fruit growers. Therefore, it is necessary to produce quality planting material for distribution among the fruit growers. For the purpose, a rapid method for multiplication of planting material of pomegranate is needed to obtain good quality plants (Frey *et al.*, 2006) [7]. The pomegranate is propagated by seeds, cuttings, layering, offshoots and grafting. Of these methods of propagation, cutting is the most used form of multiplication in pomegranate. Propagation by stem cuttings are simple, easily to perform, rapid, economic and works well. New plants developed from stem cutting are true to type and uniform in growth. Such plants come into bearing earlier than the seedlings and do not require any special techniques necessary in grafting and layering (Owais, 2010 and Saroj *et al*., 2008) [17, 23]. Pomegranate can be propagated from softwood or hardwood cuttings. Hardwood cuttings are the preferred means of propagation, but softwood cuttings collected in early fall can be used with varying degrees of success. A tree from a hardwood cutting will bear fruit in a year or two after planting, while it will take at least three years from seed. Further propagation by seed leads to enormous variability in the progenies. Propagation by seed is unable to perpetuate characters of the parent tree. The seedling trees have long juvenile period and more vigorous growth habit which poses problem in performing various horticultural operations. Moreover, the fruits of seedling trees do not mature in one stroke and thereby affect their marketing. The other techniques of vegetative propagation of pomegranate, namely, layering, and grafting are cumbersome, laborious, time consuming and required skilled gardener. Not only this, these technique particularly layering is un-economical since only one plant is obtained from a long scion shoot. Because of development of more number of plants in short period and also because of development of plants more easily without requiring skilled gardener, stem cutting technique of vegetative propagation is better provided its success rate is improved.

Of the pre-planting treatments, rooting medium has been adjudged to be the most critical factor determining sapling quality in the nursery acting as a reservoir for nutrients and moisture. It is the important input for better sapling production.

It directly influences the growth, development, ramification and functioning of rooting system. An ideal rooting medium should be loose, porous with high water holding capacity. Rooting medium holds cutting in place, holding moisture content for new emerged roots, congenial conditions for respiration and maintains optimum temperature for the root initiation. The nature of roots arising from the cuttings is also influenced by the type of rooting medium e.g., cutting when planted in pure sand produced long, un branched, coarse and brittle roots but those planted in a mixture of sand, soil and peat, produce well developed branches (Chattopadhaya, 1994) [4]. Besides pre-planting treatments, the growing condition also significantly affected the performance of stem cutting (Owen 2007 and Kumawat, 2010) [18, 12]. Higher success, survival and better shoot and root growth were observed in stem cuttings when grown in net house or under controlled condition (Atayi, 2011) [2].

The research findings on the above aspects of propagation in pomegranate are rather meagers and inadequate (Baloni *et al*., 2017, Kumari *et al*., 2013 and Rajkumar *et al*., 2016) [3, 11, 20]. Moreover, the success rate in case of stem cutting without auxin, nutrient and wounding and rooting media treatments is not very encouraging (Manila *et al*., 2017 and Panday and Bisen, 2010) [13, 19]. Therefore, it was realized to ascertain the performance of stem cutting under different conditions with auxin, nutrient, wounding and rooting media treatments.

Materials and Methods

The present investigation entitled "Effect of different rooting media treatments on rooting and growth of stem cuttings in pomegranate (*Punica granatum* L.)", was conducted at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, 250110 (UP), during 2016 and 2017. University is located about 70 Km. away from National capital Delhi, India on National Highway No. 58. Geographically, University is located at 29.01˚ North latitudes, 77.75˚ East longitudes at an altitude of 237 meter above from mean sea level (MSL). The field experiment was conducted in a Randomized Block Design (RBD), replicated thrice during 2016 and 2017. The experimental materials included three rooting media were prepared and filled in polybags. About 1-1.5 kg rooting medium was filled in each polybag. The rooting media were disinfected with carbendazim before planting of stem cutting in polybag. The details of rooting media used for the study are as follows:

1. Soil + Sawdust + Vermi-compost @ 1:1:1
2. Soil + Sand + Vermi-compost @ 1:1:1
3. Soil + Sand + FYM @ 1:1:1

Results and Discussion

A propagation study find out the impact of rooting media on rooting and growth of stem cutting in pomegranate. Different quantitative and qualitative attributes pertaining to propagation were recorded during the course of investigation. The results obtained on different parameters are summarized under the following heads:

Days taken for bud sprouting

Of the rooting media, significantly early sprouting was recorded in stem cuttings grown in Soil + Sand + Vermi-compost (12.39 days) followed by Soil + Sand + FYM (12.98 days) and Soil + Sawdust + Vermi-compost (15.14 days) during both the years of study. In comparison to Soil + Sawdust + Vermi-compost, bud sprouting was advanced by 2.76 days with Soil + Sand + Vermi-compost.

Sprouting percentage

When compared the effect of different rooting media on sprouting percentage it was found that cuttings grown in Soil + Sand + Vermi-compost rooting medium had significantly higher sprouting percentage (99.08%) followed by Soil + Sand + FYM (98.33%) and Soil + Sawdust + Vermi-compost (94.0%) during both the years. A maximum of 5.40% increase in survival percent was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Survival percentage

The rooting media also significantly affected the success percent of stem cutting. Of the rooting media, significantly higher survival percent of stem cutting was recorded with Soil+ Sand +Vermi-compost (84.25%), while Soil + Sand + FYM (80.50%) and Soil + Sawdust + Vermi-compost (67.33%) were found to be second and third best rooting medium, respectively in respect of survival percent during both the years. A maximum of 25.12% increase in survival percent was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Number of shoots

While examining the performance of different rooting media on shoot production in stem cutting, it was observed that stem cuttings planted in Soil + Sand + Vermi-compost rooting media had significantly higher number of shoot (5.34) than other rooting media. The Sawdust containing rooting medium had significantly recorded minimum number of shoots (3.60) during both the years. A maximum of 48.33% increase in number of shoots was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Shoot length

The stem cutting grown in Sand and Vermi-compost containing rooting medium had significantly higher shoot length (54.48 cm) than those grown in Soil + Sand + FYM (48.18 cm) and Soil + Sawdust + Vermi-compost (36.18 cm) during both the year of investigation. A maximum of 50.58% increase in mean shoot length was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Length of longest shoot

Irrespective of treatments, rooting media had also affected the length of longest shoot per cutting. Significantly maximum length of longest shoot per cutting was recorded in cuttings grown in Soil + Sand + Vermi-compost (84.12 cm) followed by Soil + Sand + FYM (77.48 cm) and Soil + Sawdust + Vermi-compost (64.16 cm) during both the years. A maximum of 31.10% increase in length of longest shoot was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Diameter of longest shoot

When the effect of different rooting media on diameter of longest shoot was examined, it was found that cuttings grown in Soil + Sand + Vermi-compost had significantly higher diameter (4.79 mm) of longest shoot than those cuttings grown in Soil + Sand + FYM (3.37 mm) and Soil + Sawdust + Vermi-compost (3.23 mm) during both the years of investigation. A maximum of 48.29% increase in diameter of longest shoot was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Total number of leaves

Total number of leaves per cutting was found to be significantly more in cuttings grown in Soil + Sand + Vermi-compost (252.58) followed by Soil + Sand + FYM (217.02) and Soil + Sawdust + Vermi-compost (170.96) during both the years of experiments. A maximum of 47.74% increase in total number of leaves was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Total leaf area

The leaf area of stem cutting was also found to be significantly affected by rooting media. The stem cuttings grown in Sand and Vermi-compost containing rooting medium (Soil + Sand + Vermi-compost) had significantly higher leaf area (1305.18 cm^2) followed by Soil + Sand + FYM (1029.27 cm^2) during both the years.

Among the rooting media, the sawdust containing rooting medium had recorded significantly minimum leaf area of stem cuttings (570.83 cm^2) during both the years. A maximum of 128.64% increase in total leaf area was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Fresh weight of shoot

In case of rooting media, the stem cuttings grown in Soil + Sand + Vermi-compost had shown significantly higher fresh weight of shoot (24.17 g) followed by Soil + Sand + FYM (20.52 g) and Soil + Sawdust + Vermi-compost (12.94 g) during both the years. A maximum of 86.78% increase in fresh weight of shoot was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Dry weight of shoot

Irrespective of treatments, rooting media had also affected the dry weight of shoot. Significantly maximum dry weight of shoot was recorded in stem cuttings grown in Soil + Sand + Vermi-compost (16.36 g) followed by Soil + Sand + FYM (14.11 g) and Soil + Sawdust + Vermi-compost (9.42 g) during both the years. A maximum of 73.67% increase in dry weight of shoot was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Number of primary root

The rooting medium 'Soil + Sand + Vermi-compost' had significantly better effect on root development in cuttings (39.06) over Soil + Sand + FYM (35.57) and Soil + Sawdust + Vermi-compost (27.83) during both the years. A maximum of 40.35% increase in number of primary root was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Root length

Irrespective of treatments, rooting media had also affected the root length of cutting. Significantly higher mean root length of cutting was recorded in cuttings grown in Soil + Sand + Vermi-compost (28.68 cm) followed by Soil + Sand + FYM (23.89 cm) and Soil + Sawdust + Vermi-compost (18.54 cm) during both the years.

Data also revealed that sand containing rooting media had significantly better mean root length of cutting than sawdust containing rooting medium during both the years. A maximum of 54.69% increase in mean root length was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Length of longest root

The perusal of data also revealed that rooting media significantly affected the mean length of longest root of stem cutting during both the years. The stem cuttings grown in Sand and Vermi-compost containing rooting medium had significantly higher length of longest root (37.93 cm) than those grown in Soil + Sand + FYM (34.29 cm) and Soil + Sawdust + Vermi-compost (26.71 cm) during both the year of investigation. A maximum of 42.00% increase in length of longest root was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Mean root diameter

When the effect of different rooting media on mean root diameter was examined, it was found that cuttings grown in Soil + Sand + Vermi-compost had significantly higher mean diameter of root (1.71 mm) than those cuttings grown in Soil + Sand + FYM (1.33 mm) and Soil + Sawdust + Vermi-compost (0.77 mm) during both the years of investigation. A maximum of 122.07% increase in mean root diameter was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Diameter of longest root

While examining the performance of different rooting media on diameter of longest root in stem cutting, it was observed that stem cuttings planted in Soil + Sand + Vermi-compost rooting media had significantly higher diameter of longest root (2.92 mm) than other rooting media. The Sawdust containing rooting medium had recorded significantly minimum diameter of longest root (1.21 mm) during both the years. A maximum of 141.32% increase in diameter of longest root was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Fresh weight of root

The effect of rooting medium Soil + Sand + Vermi-compost on fresh weight of root of cutting was found to be significantly higher (9.21 g) followed by Soil + Sand + FYM (7.58 g) and Soil + Sawdust + Vermi-compost (5.03 g) during both the years. A maximum of 83.10% increase in fresh weight of root was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Dry weight of root

In case of rooting media, the stem cuttings grown in Soil + Sand + Vermi-compost had recorded significantly higher dry weight of root (6.70 g) followed by Soil + Sand + FYM (5.20g) and Soil + Sawdust + Vermi-compost (3.27 g) during both the years. A maximum of 104.89% increase in dry weight of root was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Percent dry weight of root

The rooting media also significantly affected the percent dry weight of root of stem cutting. Of the rooting media, significantly higher percent dry weight of root of stem cutting was recorded with Soil + Sand + Vermi-compost (71.72%), while Soil + Sand + FYM (67.70%) and Soil + Sawdust + Vermi-compost (63.68%) were found to be second and third best rooting medium, respectively in respect of percent dry weight of root during both the years. A maximum of 12.62% increase in percent dry weight of root was recorded with Soil + Sand + Vermi-compost over Soil + Sawdust + Vermi-compost.

Discussion

In the present study cuttings grown in Soil + Sand + Vermi-compost sprouted early than those grown in sawdust and FYM containing rooting media. The better response of vermi-compost and sand containing rooting medium may be attributed to optimum nutrient uptake and enhanced availability of nutrients and growth promoting substances in the vermi-compost containing rooting (Suhane, 2007 and Munroe, 2007) [29, 15].

Infact earthworms vermi-compost is proving to be highly nutritive 'organic fertilizer' and more powerful 'growth promoter' over the conventional composts and a 'protective' farm input. Vermi-compost is rich in NPK (nitrogen 2-3%, phosphorus 1.55-2.25% and potassium 1.85-2.25%), micronutrients, beneficial soil microbes and also contain 'plant growth hormones and enzymes'.

It is scientifically proving as 'miracle growth promoter and also plant protector' from pests and diseases. Vermi-compost retains nutrients for long time, while the conventional compost fails to deliver the required amount of macro and micronutrients including the vital NPK to plants in shorter time (Sinha *et al*., 2009) [26].

Another possible reason for early sprouting in stem cuttings grown in soil + sand + vermi-compost rooting medium in the present study might be because of optimum availability of water and nitrogen in the rhizosphere due to the presence of vermi-compost in the rooting medium which might have facilitated better uptake of nitrogen, the chief constituent of amino acid and co-enzymes that are of biological importance. Optimum N uptake might have reduced the C: N ratio and thereby inducing buds at earlier days (Kumar and Ponnuswami, 2013) [10].

This may also be due to higher net assimilation on account of better growth leading to the production of endogenous metabolites earlier in optimum level enabling early bud initiation and thereby early sprouting. Vermi-compost contains 'humus' excreted by worms which makes it markedly different from other organic fertilizers. Vermi-compost has also greater 'water holding capacity' due to humus contains and hence reduces the requirement of water for irrigation by 30-40%. Without humus, plants cannot grow and survive. On the other hand delayed sprouting in control cuttings in the present study might be because of the fact that control cuttings had neither been treated with bio-regulator nor been wounded (Mohammed, 2001 and Silva, 2005) [14, 24]. As a result, nutrient availability in control cuttings is reduced as compared to cuttings treated with IBA and wounding.

In the present study sprouting was delayed in cuttings grown in sawdust rich rooting medium as compared to vermi-compost and sand containing medium. This may be due to the fact that when sawdust is incorporated in the vermi-compost containing medium in the present study, the moisture level in the medium might have increased excessively because of high water retaining capacity not only of sawdust but also of vermi-compost (Sinha *et al*., 2014) [25]. As a result, the sprouting as well as survival of cutting both are affected when grown in Soil + Sawdust + Vermi-compost rooting media because of excess moisture in the medium which may resulted in causing pathogen infection in the medium due to poor aeration and excess moisture (Sardoei, 2014 and Sirin, 2010) [22, 27].

Further, addition of vermi-compost and sand in the sawdust deficient rooting medium create favourable condition for optimum growth of cuttings due to better moisture retaining capacity, and high nutritive and growth promotive values of vermi-compost and also due to better aeration, drainage and porous quality of sand (Khalaj, *et al*., 2011) [9].

In the present study better results were obtained when stem cuttings were grown in vermi-compost and sand containing rooting medium (i.e. Soil + Sand + Vermi-compost) rather that FYM and sand containing rooting medium (Soil + Sand + FYM). This may be due to the fact that vermi-compost is at least 4 times more nutritive that conventional cattle dung compost (Suhane, 2007 and Munroe, 2007) [29, 15]. Therefore, due to quick and rapid availability of nutrients to the cuttings grown in the vermi-compost containing rooting medium, which contained good amount of plant available nutrients in comparison to FYM, themost probably buds sprouted early in stem cutting (Adak *et al.*, 2014) [1]. Further, unlike vermi-compost FYM does not retain nutrient for long time and fails to deliver the required amount of macro and micronutrients including the vital NPK to plants in shorter time, the vermi-compost does (Sinha *et al.*, 2009) [26]. Hence, lesser availability of N in the FYM containing growing medium might be the reason for delayed bud sprouting.

Table 1: Pooled effect of rooting media treatments on shoot growth of stem cutting in pomegranate

Treatments	Days taken for bud sprouting	Sprouting percentage (%)	Survival percentage (%)	Number of shoots	Mean shoot length (cm)	Length of longest shoot (cm)	Diameter of longest shoot (mm)	Total number of leaves	Total leaf area (cm^2)	Fresh weight of shoot (g)	Dry weight of shoot (g)
Mean (Soil + Sawdust + VC)	15.15	94.00	67.33	3.60	36.18	64.16	3.23	170.96	570.83	12.94	9.42
Mean (Soil + Sand + VC)	12.39	99.08	84.25	5.34	54.48	84.12	4.79	252.58	1305.18	24.17	16.36
Mean (Soil + Sand + FYM)	12.98	98.33	80.50	4.69	48.18	77.48	3.37	217.02	1029.27	20.52	14.11
CD(5%)	0.113	1.611	2.557	0.088	0.682	0.879	0.051	2.961	21.669	0.265	0.275

VC = Vermi Compost
FYM = Farm Yard Manure

Table 2; Pooled effect of rooting media treatments on root growth of stem cutting in pomegranate

Treatments	Number of primary root	Mean root length (cm)	Length of longest root (cm)	Mean root diameter (mm)	Diameter of longest root (mm)	Fresh weight of root (g)	Dry weight of root (g)	Per cent dry weight of root
Mean (Soil + Sawdust + VC)	27.83	18.54	26.71	0.77	1.21	5.03	3.27	63.68
Mean (Soil + Sand + VC)	39.06	28.68	37.93	1.71	2.92	9.21	6.70	71.72
Mean (Soil + Sand + FYM)	35.57	23.89	34.29	1.33	2.43	7.58	5.20	67.70
CD(5%)	0.269	0.253	0.331	0.012	0.022	0.160	0.095	0.778

Conclusion
The rooting medium 'Soil + Sand + Vermi-compost' had shown most significant effect over other rooting media in respect of sprouting, survival, shoot and root growth of stem cutting.

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